New Manganese Silicide Mineral Phase in a Cometary Interplanetary Dust Particle

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We report a new mineral from one of the cluster interplanetary dust particles (IDPs) of the comet Grigg-Skjellerup collection, L2055. Our report focuses on an unusual manganese-iron-chromium silicide phase that, to our knowledge, has not been observed previously in nature.

We found three unusual Mn-rich crystalline grains (100, 200 and 250 nm in diameter) in IDP L2055I3. The major elements are Si and Mn, with minor Fe and Cr, and O is below detection limits for both EDX and EELS analysis. Based on quantitative EDX data, the stoichiometry of the new phase is (Mn, Cr, Fe)Si. Electron diffraction data reveal that these Mn-rich grains are single crystals with a cubic symmetry. The crystal structure and *d*-spacings are in excellent agreement with diffraction data for synthetic MnSi [1]. Synthetic manganese silicides (Mn_xSi_y) with composition *x* and *y* take quite a variety of forms and crystal structure changes depending on x and y, although only the simple MnSi assumes cubic symmetry ($P2_13$, a= 4.558Å).

This unique phase may also shed light on the genesis of the enigmatic low-Fe, Mn-enriched (LIME) olivine [2]. One of the MnSi grains in IDP L2055 has a core-mantle structure, having multiple concentric layers with a MnSi core surrounded by different LIME olivine layers with variable Mn-contents. High resolution imaging shows that the LIME olivine c* is epitaxial to the MnSi (200). LIME olivine was first reported from chondritic porous IDPs and some ordinary chondrites [2], and has been commonly observed in IDPs since then. Recently, LIME olivine was also found in comet Wild-2 dust samples returned by the NASA Stardust mission [3], suggesting that LIME olivine is a common mineral component of comets. LIME olivine has been proposed to form from condensation in the protosolar nebula [2].

We are planning to measure Si isotope of this phase using the JSC NanoSIMS 50L, which may help to constrain the origin of this unusual phase.

Keywords: comet; interplanetary dust particles; IDPs; TEM; MnSi

References

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